

Final Project: Space Station Andromeda

Overview

Your client is the coordinator of ship and personnel systems for Space Station Andromeda: *Lawrence David*. In his job, he schedules the docking and undocking of all ships at the station, as well as the crew services provided for each ship.

Commander David has been managing operations for many years now. He does so by using a Lotus 1-2-3 spreadsheet and a FoxPro 2.0 database on an ancient personal computer with an i386 processor. He is able to satisfy his job requirements and does not believe there is any need to change how things are done. The system, however, is far from efficient. This has impact when some of the services must be performed quickly.

Captain David has a new boss: *Admiral B-boy Trager*. Admiral Trager ***hates*** any technology or system that is not on the cutting edge. He recently informed Captain David that the “old way” of doing things will no longer be accepted. Further, in five weeks, Admiral Trager plans to *personally* destroy the current equipment by driving over the i386 machine (multiple times) in his quad-cab space truck. The new system must be in place by then or Captain David will be thrown out the air lock.

This will *not* be a simple job. Your organization has only five weeks to analyze, code, test, and deploy this new solution. You will need to start ***now***. ***Plan on spending many long days and nights working to get this done.***

Nine other developers will be working on this project as well. Each of you will work independently. When all nine developers are finished, Admiral Trager and Commander David will decide whose system will be adopted. The developer of the selected system will win an all-expense-paid trip to the vacation planet of his/her choice. A personal, luxury, space limousine will be available for the winner’s use at all times.

(Second, third, and fourth place developers win a three-day trip to Newark, New Jersey on planet Earth. Public transportation must be used by the prize-winners; this reward does not cover transportation costs.)

Andromeda Station

Andromeda Station is one of the newer Federation way-stations. Located in the Ontario galaxy, it services over 1,000 ships (and their crews) per year.

The station has twenty docking bays ranging from category 1 ships (personal, one or two-man ships called skeeters) through category 12 ships (dreadnaught war ships). Each bay has its own set of characteristics that determine what ships/crews can use it. More information regarding the docking bays can be found later in this document.

The Station and Ship Crew

There are approximately 2,400 crew members working on the station at any given time. The crew members are a blend of three major races in the federation: Humans, Amphibians, and Megas. A brief description of each follows:

- Humans** Originally from Earth in the Sol system, humans started exploring the galaxy starting in 2125. Humans are oxygen-breathing, soft-skinned, and easily damaged. Most humans can lift approximately 100 pounds without assistance.
- Amphibians** Amphibians come from Waterland, a planet in the Hydroxy galaxy. Amphibians are water-breathers. In water, they are extremely fast and strong. They can survive for brief periods of time (less than 30 minutes) out of water if necessary. Their scales are extremely strong, making this a race that is hard to damage.
- Megas** Coming from the Metallica galaxy, Megas developed on a system of high-gravity planets. While only three-to-four-feet tall, a single Mega can lift well over ½ ton. Their dense, rock-like skin makes them impervious to most projectile and energy weapons. They can, however, be negatively affected by radiation. Due to their dense cell-structure, Mega ships and Mega areas of the station require extra reinforcement of all floor structures. Megas function mostly in an oxygen atmosphere but their slow respiration rate allows them to work for short periods in water environments.

Each of the three races man their own ships; ships with multi-race crews are unusual and occur rarely.

At times, multiple races must work together to maintain a ship while it is docked. The following is the compatibility matrix for the three races:

	Human	Amphibian	Mega
Human	--	No	Yes
Amphibian	No	--	For brief periods
Mega	Yes	For brief periods	--

The Docking Bays

As mentioned earlier, there are twenty docking bays available for ships requiring maintenance or restocking. Not all docking bays are the same. In some cases, you must dock a ship in a specific bay based on its size and the needs of the ship/crew that are docking.

Human ships can dock in any bay supporting oxygen.

Mega ships can dock in any bay supporting oxygen *and* with special flooring to support Mega ships.

Amphibians can dock in any bay supporting water-breathing species.

Bay	Class	Environment	Mega Floor
1,2	1-4	Oxygen	No
3,4	1-7	Oxygen	Yes
5	1-7	Aquatic	No
6,7,8	5-9	Oxygen/Aquatic	No
9,10,11	3-10	Oxygen/Aquatic	Yes
12,13	7-10	Aquatic	No
14,15	1-6	Oxygen	Yes
16,17	9-11	Oxygen	No
18	10-12	Aquatic	Yes
19,20	12	Oxygen	Yes

For example, a class 4 cruiser crewed by Amphibians can only dock in bays 5, 9, 10, and 11. Similarly, a Class 2 Skeeter crewed by Megs can only dock in bays 3, 4, 14, and 15.

The Ship Roster

As a Federation-run station, only specific, Federation ships are allowed to dock. For the Andromeda station, there is a list of 125 ships that can request docking privileges at any time.

Ships don't just "pop in and out." Once docked, the system must determine what activities need to be performed and how long it will require before the ship will undock (thus making the dock available for another ship).

The station offers a variety of services to the incoming ships including:

- Refueling

- Offloading cargo

- Onloading new cargo

- Recharging weaponry

- Cleaning the waste tanks (YUK!)

- Replenishing Food and Perishable items

- Making specific repairs, etc.

Each ship in the Ship Roster includes fields that define what services need to be performed when the ship is docked. Various services require different numbers of time cycles. For example, a class three ship

requires 1 time cycle for each 50 units of fuel added. The length of time a ship may occupy a dock is directly related to the services being performed.

Docking

A ship can only dock in a bay that (a) accepts a ship of that class, (b) has the correct environment, and (c) has the correct flooring. (See the note under *Docking Bays*)

Changing the environment for a docking bay (e.g., changing from an Oxygen Environment to an Aquatic Environment and the reverse) requires 30 time cycles.

Docking and undocking requires time.

Ships dock in the order they appear in the ship queue. A ship *must* be docked before the next ship in the queue can be processed.

Time Lines

Activity	Time	Trigger
Assign Dock	0	Selection in application
Prepare Dock	10 cycles for basic setup 30 cycles if Oxygen/Amphibian changeover	Ship is assigned to dock
Dock the Ship	Varies by class	Docking Action
Refuel	1 time cycle for each 50 units of fuel	All ships are topped off to maximum capacity
Cargo Load	4 time cycles for each 20 units of cargo	Provided with ship detail
Cargo Unload	4 time cycles for each 20 units of cargo	Provided with ship detail
Clean waste tanks	6 time cycles for each 30 units of waste removed	Calculation: Waste Capacity – current waste
Make Repair	Depends on specific repair	Repair class provided with ship detail
Replenish Food	Depends on food needed	Food class provided with ship detail
Undock Ship	Varies by class	Service completion

Operational Scenario

1. Initially, all docks are empty.
2. The “pending list” is loaded with all ships that are waiting for their opportunity to dock and be serviced.
3. Captain David reviews the first ship in the “pending” list and assigns it to a dock. This involves:
 - a. Assessing which open bays can accept a ship of that class
 - b. Assessing which of the bays identified in 3.a has the necessary features for the ship (environment, flooring, etc.)
4. Automated processing takes over:
 - a. preparing the docking bay,

- b. docking the ship in the docking bay,
 - c. report ship arrival,
 - d. assess standard and optional services needed,
 - e. performing the standard services,
 - f. performing optional services,
 - g. releasing the ship from the docking bay,
 - h. report ship departure, time elapsed, and all services performed.
5. Repeat from Step 3 until all ships processed

This introduces some interesting side effects.

1. There may be times when some docks might be empty because of a “stalled” queue of available ships (e.g., there is not an appropriate dock available for the next ship in line).
2. There might be times when all docks are full, blocking the queue.
3. Different ships may require different amounts of time for servicing. For example, a large ship might only require a few time cycles if it is just being refueled while a smaller ship might take significantly longer because of needed repair work.
4. All services for a ship must be completed before a ship can be released.

Docking Timings by Ship (cycles)

Ship/Class	Docking Time (cycles)	Undocking Time (cycles)
Runabout / Class 1	3	1
Personal / Class 2	3	2
Skeeter / Class 3	4	3
Small Shuttle / Class 4	4	4
Medium Shuttle / Class 5	5	4
Large Shuttle / Class 6	7	4
Personnel Transport / Class 7	9	9
Cargo Transport / Class 8	7	9
Cargo Transport II / Class 9	9	11
Scout Ship / Class 10	8	6
Explorer / Class 11	11	12
Dreadnaught / Class 12	15	17

Maximum Defense Power Units by Ship

Ship/Class	Defense Power
Runabout / Class 1	100
Personal / Class 2	150
Skeeter / Class 3	200
Small Shuttle / Class 4	250
Medium Shuttle / Class 5	500
Large Shuttle / Class 6	750

Personnel Transport / Class 7	1200
Cargo Transport / Class 8	1200
Cargo Transport II / Class 9	1400
Scout Ship / Class 10	2000
Explorer / Class 11	5000
Dreadnaught / Class 12	12000

A ship is a ship is a ship

Ships are described by a specific set of values contained within the docking request record. These values are:

- The Ship's Name
- The Ship's Class
- The Ship's Federation ID number
- The Pilot or Captains Name
- The amount of fuel currently on board and the total fuel capacity
 - The amount of cargo on board to be unloaded at Andromeda station
 - A manifest showing the amount of cargo to be loaded onto the ship
 - The amount of waste currently on board and the total waste capacity
 - An indicator of whether the ship is currently docked
- Repair request code: 0-5 (see reference)
- Food request code: 0-5 (see reference)
- Defenses power level: 0-100 (see description)
- Ship's Crew Race (Human, Amphibian, Mega)

Every ship needs a station!

Andromeda Station has its own set of characteristics

- The station's name
- A list of all the ships currently docked at the station
- A list of all the ships currently waiting to dock for service

The station also needs to be able to perform a variety of actions on each ship. Each of those actions is described below:

Prepare Dock – Set the dock up to receive a specific ship as assigned by Captain David. This activity begins as soon as the ship is assigned to the dock. Preparation time is tracked, beginning with the time the docking instruction is given.

Dock Ship – Display the name of the ship, set its *docked* property to true, and add it to the list of ships currently docked at the station. Once docked, check the ship to see what other actions need to occur.

Refuel Ship – Calculate the amount of fuel necessary to “top off the tanks” of the ship. Display a message that indicates how much fuel was added. Track time.

Unload Ship – If the ship has cargo for Andromeda Station, unload it, tracking time as directed.

Load Ship – If Andromeda station has cargo to load, do so and track the time needed.

Empty Waste – If the waste compartment is more than 10% full, you need to empty it completely! (Anyone in trouble with the station’s admiral gets to sanitize it after emptying!) Be sure to display a message saying how much waste was dumped.

Perform Repairs – Check the repair value. If zero, no repairs are needed. If greater than zero, check to see how long that level of repairs requires on that class of ship. Track the time.

Stock Food – Check the food value. If zero, no food is needed. If greater than zero, calculate to see how long is required for that amount of food to be loaded for that class ship.

Recharge Defenses – Check the reference table to see what the ship defenses power level should be for that class. Then, recharge the defenses power to that maximum. Take note of how long is required. Recharging defenses requires 5 time cycles for each 100 units of charge.

Undock Ship – Remove the ship from the stations dock list and change the ship’s flag to indicate that it is not docked.

Report – Produce a listing with the ship’s information, the services were performed and the timing involved. At the end of the report, you should list the total time for all activities.

Lookup Tables (Cycles)

Perform Repairs					
Code	1	2	3	4	5
Ship/Class					
Runabout / Class 1	4	5	6	9	10
Personal / Class 2	5	5	5	8	9
Skeeter / Class 3	4	6	6	9	9
Small Shuttle / Class 4	5	5	7	9	11
Medium Shuttle / Class 5	7	9	10	10	12
Large Shuttle / Class 6	8	10	11	12	14
Personnel Transport / Class 7	9	11	13	14	16
Cargo Transport / Class 8	11	13	15	17	19
Cargo Transport II / Class 9	11	13	17	18	19
Scout Ship / Class 10	7	7	7	9	9
Explorer / Class 11	12	14	19	20	11
Dreadnaught / Class 12	15	18	21	24	30

Load Food

Ship/Class	Code	1	2	3	4	5
Runabout / Class 1		4	5	6	9	10
Personal / Class 2		5	5	5	8	9
Skeeter / Class 3		4	6	6	9	9
Small Shuttle / Class 4		5	5	7	9	11
Medium Shuttle / Class 5		7	9	10	10	12
Large Shuttle / Class 6		8	10	11	12	14
Personnel Transport / Class 7		9	11	13	14	16
Cargo Transport / Class 8		11	13	15	17	19
Cargo Transport II / Class 9		11	13	17	18	19
Scout Ship / Class 10		7	7	7	9	9
Explorer / Class 11		12	14	19	20	11
Dreadnaught / Class 12		15	18	21	24	30

Expectations

Design Expectations

For the design aspect of this project, you are expected to perform and document all of the following analysis:

- Requirements Capture and documentation

- Narrative Analysis

- Domain Analysis

- Use Case Analysis

- Use Case Descriptions

- Domain Analysis with all relations and cardinality

- Domain Analysis with attributes

- Class Analysis with attributes and methods

Each deliverable requires full documentation.

Implementation Expectations

In implementing this project you are expected to satisfy the following requirements:

- Appropriate naming conventions will be consistently used for all classes, attributes, and methods.

- Every class will have an opening set of comments describing the class and its purpose. Every class variable will have a comment explaining its use/purpose.

- Every method will have a comment block explaining what the method does, any input parameters, and any return values.

- In-line comments will be used where the purpose of the code is not obvious.

- All code will be formatted to course standards.

Example

For this example, we will look at the processing for a single ship. The details of this ship are as follows:

Ship Name: Magellen
Class: 5 (Medium Shuttle)
Federation ID: SOL-14973E
Captain: Jean-Luc Trager
Available Fuel: 150
Maximum Fuel: 2000
On-board Cargo: 150
Expected cargo: 300
Current waste: 750
Total Waste Capacity: 1200
Repair Code: 3
Food Code: 5
Defense Code: 100
Crew Race: Human
IsShipDocked: No

Assume this ship has come to the front of the queue. Dock 10 is available, but is currently set up as an Aquatic environment. Here are the timings that might occur:

Docking assigned: Dock 10. Last use Aquatic

<u>Action</u>	<u>Time Cycles</u>
Convert Dock 10 to Oxygen Environment	30
Dock	5 (Set IsShip Docked)
Report Ship Arrival	0
Assess service needs	0
Refuel 2000-150 = 1850 units needed at	37
Cargo Offload (4 cycles per 20 units) 150	30
Cargo on-load	60
Clean Waste (1200-750)	250
Repairs	10
Load Food	12
Charge Defenses (500 - 100)	20
Undock Ship	5 (Reset IsShipDocked)
Report Ship Departure	0
Total Time Cycles for this ship:	459